Question 1. **[10]**

This experiment determines the focal length of a lens by combining it co-axially with another lens. Determine the focal length of the lens A by the distant object method, that is, by focusing the image of a distant object on a wall and measuring the distance of the image from the lens directly by a meter ruler. Take the mean of three such measurements.
Let it be f_1.

Set up the two given convex lenses A and B co-axially on an optical bench as shown in the figure 1.

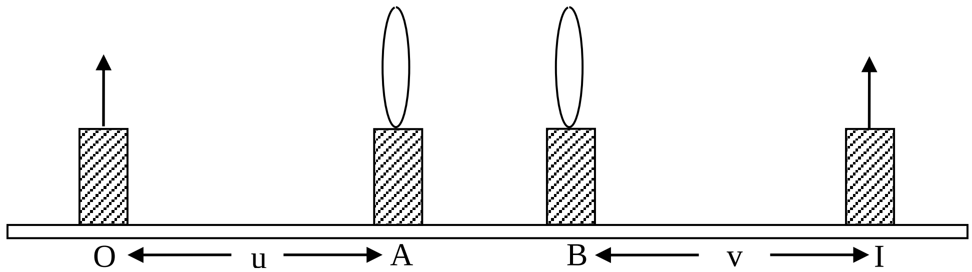

Figure 1

Place the lens A on the optical bench at about 10 cm to the left (or right) of the 50 cm mark. The lens B is placed on the other side of the 50 cm mark so that AB=f_1. Thus, the lenses A and B are on the opposite sides of the 50 cm mark of the optical bench. An object pin O is placed on the left side of the lens A, at distance OA=f_1. A real image of the object pin is formed on the right side of the lens B. Obtain the position of this image by removing parallax between this real image and image pin I. Record the positions of O, A, B and I (correct to 1mm) in a neat tabular column with correct units. Also, record OA=u and BI=V in cm. Calculate $y = \frac{100}{V}$ and $x = \frac{u}{100}$. Enter y and x also in the tabular column.

Show your first set of tabulated readings to the Visiting Examiner.

Take 4 more set of readings, increasing u by about 5 cm each time, preferably keeping A and B fixed and moving the object needle O. The distance between the lenses AB=f_1 is kept the same for all the five sets of observation.

Plot a graph of y versus x. Draw the best fit straight line. Obtain the slope $S = \frac{\Delta y}{\Delta x}$.

Calculate the power of one of the lens $P = \sqrt{S}$ and focal length $f = \frac{100}{P}$. Record your result with correct unit and give the answer up to three significant figures.

Question 2. **[4]**

Set up a potentiometer with the electrical circuit as shown in Figure 2.

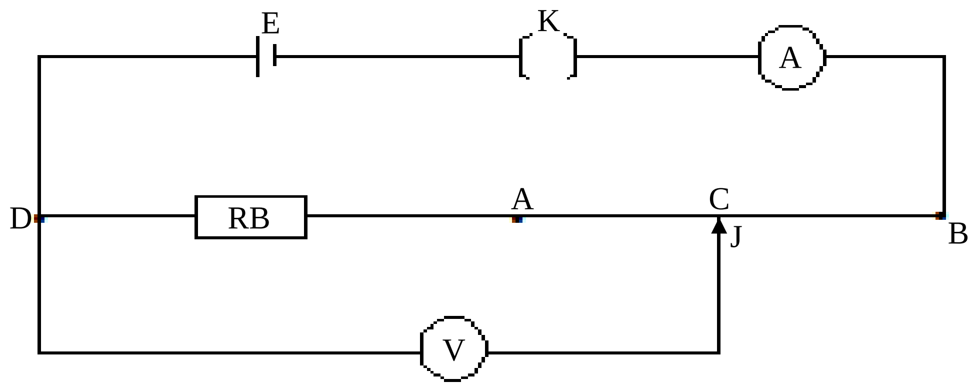

Figure 2

AB is a uniform resistance wire of length 100 cm. A resistance box RB is connected in series with the wire AB, a dc source of emf E, an ammeter A, and a key K. A voltmeter and a jockey are connected as shown in figure 2. Take out a plug from RB and close the key K. The current reading in the ammeter should be within scale.

Record the least count and range of ammeter and voltmeter. Touch the jockey at the far end (near B) of the wire AB and note the reading of the voltmeter. Adjust the value of R in the box so that the reading of the voltmeter is maximum. Keep this value of R and the current reading in the ammeter fixed. Take reading (V) of the voltmeter touching the jockey at C with AC=20 cm. Tabulate your observations V and AC (l).

Show your first set of tabulated readings to the Visiting Examiner.

Repeat the experiment for four more values of A (l) =40, 60, 80 and 100 cm and obtain the respective values of V. Tabulate the values of V and AC (l) by keeping the ammeter reading the same always. Record the value of the resistance R in RB and ammeter reading I, above in a tabulator column.

Plot a graph of the variation of the potential difference V versus length AC=l. Read the intercept V_0 for l=0, Calculate $R' = \frac{V_0}{I}$ where I is the current reading in the ammeter (kept constant). Record your result in three significant figures and unit.

Question 3. **[6]**

Measure the emf of the given dry cell using the potentiometer of Question 2. Disconnect the voltmeter and connect a single dry cell of emf E_1 and a galvanometer G, in its place as shown in figure 3.

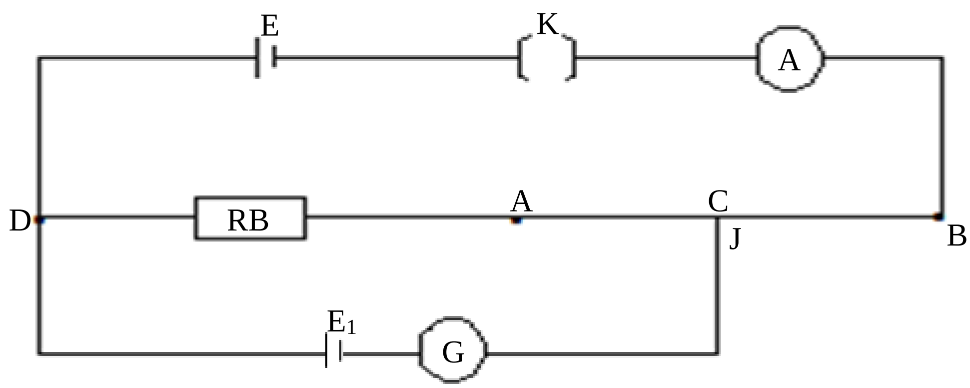

Figure 3

With the key K switched on, and the resistance in the RB as same as in Question 2, touch the jockey J near the ends A and B of the wire AB for a moment only. The galvanometer needle must show deflections in the opposite directions. By trail obtain the point C_1 at which when the jokey makes contact with the wire, the galvanometer needle shows no deflection. Note down the length $AC_1=l_1$ (up to mm). Also record the value of R in the RB as well as the reading of the ammeter.

From the graph of Question 2, read the potential difference V_1, corresponding to the length $AC_1= l_1$. Hence obtain the emf of the cell E_1. Record your result.

Answer the following questions:

(i) What is the main advantage of using a null method in any experiment?

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(ii) What is the special advantage of using a null method in the measurement of the emf of a cell compared to the direct measurement with a high resistance volt meter?

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(iii) State ***one*** similarity and ***one*** difference between an ammeter and a galvanometer.

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